

Morphological evolution and heritability estimates for some biometric traits in the *Murgese* horse breed

C. Dario, D. Carnicella, M. Dario and G. Bufano

Department of Animal Health and Welfare, University of Study of Bari, strada prov.le per Casamassima, km 3, 70010 Valenzano, Ba, Italy

Corresponding author: C. Dario

E-mail: c.dario@veterinaria.uniba.it

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ABSTRACT. A data set concerning 1,816 subjects entered in the Italian Horse Registry from 1925 to 2002 was analyzed to investigate the morphological evolution of the Murgese horse and to obtain useful elements to enhance breeding practices. Three basic body measurements (height at withers, chest girth, and cannon bone circumference) were considered for each subject. Heritabilities were calculated for each parameter to infer the growth and development traits of this breed. Over the past 20 years the Murgese horse has undergone considerable changes, passing from a typical mesomorphic structure (height at withers: 156.30 and 151.04 cm; chest girth: 185.80 and 176.11 cm; cannon bone: 21.10 and 19.82 cm for males and females, respectively) to a mesodolichomorphic structure (height at withers: 160.31 and 156.44 cm; chest girth: 187.89 and 182.48 cm; cannon bone: 21.07 and 20.37 cm, for males and females, respectively). Due to these changes and to its characteristic strength and power, the Murgese, which was once used in agriculture and for meat production (at the end of its life), is now involved in sports,

mainly in trekking and equestrian tourism. The heritability estimates for the three body measurements were found to be 0.24, 0.39 and 0.44.

Key words: Horse, Murgesse, Biometric traits, Heritability

INTRODUCTION

Origins

Over the Murgia hillsides interspersed with *trulli* (typical cone-shaped houses) and bordering the Apulian provinces of Bari, Brindisi and Taranto, there is a breed of carefully selected horses, called Murgesse. This horse has Spanish, Neapolitan, Berber, and Arabian ancestors and its origins date back to the 15th and 19th centuries (Basile, 1956; Pagano, 1975; Aurigi, 1986; Buonavolontà and Silvestrelli, 1986; Catalano, 1993). This horse breed was fully developed in the 1920s; it originated from local horses found in the arid and rocky Italian hills of Apulia, from which takes its name: *le Murge* (Mason, 1996). The Murgesse horse has a blackish, iron-grey coat; it has great rusticity and a fine powerful appearance because it was grown wild on the open range.

The Murgesse was a useful, easily manageable farm horse and a good worker; it was highly valued for its rustic nature, which was necessary for its survival in such a harsh environment. Its conformation and characteristics made it particularly suitable for raising cattle. The mares were also used to breed strong mules when the production of these hybrids was required (especially for the army during World War II).

The Murgesse today

The modern Murgesse is a light draft horse with variable types; it is an extremely docile animal and easily becomes used to saddles and harnesses. It is amenable to equestrian tourism and cross-country riding because of these qualities.

Another important characteristic, along with its obedience, is its learning ability, which qualify the Murgesse for the complicated exercises of haute cole, steeple chasing and for physiotherapy. The Murgesse horse is likewise a superb grazer and makes good use of poor pastures, especially in the mountain regions. The Italian Forestry Service uses the Murgesse for service all over Italy. The Murgesse is also highly resistant to diseases, so much so that organic disorders, such as heaves and intestinal diseases, are practically non-existent in this breed. It has a robust skeleton and muscles, as well as a tough and thick epidermis, which plays an important role in protection against insect bites and thorny vegetation.

Effective selection for the improvement and conservation of a pure breed has ensured these valuable aptitudes and extremely desirable traits in the Murgesse horse, which is now receiving rapid and well-deserved notoriety. The Murgesse herdbook (a breeder's census) has only been kept since the 1920s, when the Italian government's horse breeding association took an active interest in preserving this unique breed. There are currently 1089 herdbook entries

(AIA, 2003). Since the endangered status of animal breeds is determined by the size of the breeding stock (Bodò, 1990), the Murgese horse was classified as vulnerable, and measures were taken to prevent a further decrease in its numbers.

We analyzed three basic body measurements (height at withers, chest girth and cannon bone circumference) and estimated the heritabilities for the biometric traits measured at registration in order to assess the morphological evolution and genetic characteristics of this breed.

MATERIAL AND METHODS

Data

Data collected in the period from 1925 to 2002, regarding 1,816 animals (905 mares and 911 stallions) registered in the official genealogical herdbook of the Murgese horse were analyzed. Based on the year of birth and stallion reproduction period (an average of seven years) the dataset was divided into eight classes covering seven years each (1925-49; 1950-57, 1958-65, 1966-72, 1973-79, 1980-87, 1988-95, 1996-2002), except for the first period, which was extended because the number of findings was too small to obtain reliable estimates.

The traits were the three basic biometric measures used for horses (height at withers, chest girth and cannon bone circumference). Following a standard protocol, measurements were taken as follows: height at withers (measuring tape) is the distance from the highest point of the processus spinalis of the thoracic vertebra to the floor; chest girth (measuring tape) measured at the saddle girth; circumference of the cannon bone (measuring tape): smallest circumference of the forelimb cannon bone.

Statistical analysis

Statistical analysis was performed by SAS (SAS, 1998). The dataset was analyzed using the GLM procedure, considering the fixed effect of classes, sex type and sire. Means were compared by the *t*-test.

In order to estimate the genetic parameters (heritabilities) of the biometric traits, a second dataset, including only contemporary animals (belonging to classes 6, 7 and 8) generated by 128 sires, was considered. The model included the fixed effect of year, sex and the random effect of sire, using the restricted maximum-likelihood method from the Mixed Procedure of the SAS software (SAS, 1998). Error was assumed to be randomly and independently distributed, with a mean of zero and a variance of σ_e^2 . Heritability estimates were based on the sire component of variance (σ_s^2), utilizing the following expression: $h^2 = 4 \sigma_s^2 / (\sigma_s^2 + \sigma_e^2)$. The standard error of heritability was approximated using the method described by Becker (1968).

RESULTS AND DISCUSSION

Biometric traits

The mean values of the three basic measurements (average \pm SE) are presented in Table 1. The male population has progressively and significantly ($P < 0.01$) increased in height at withers from about 156 cm for subjects included in classes 1 and 2 to 160 cm in classes 7 and 8.

Table 1. Biometric measures.

Class	N _o		Height at withers (cm)		Chest girth (cm)		Cannon bone circumference (cm)	
	♂	♀	♂	♀	♂	♀	♂	♀
1	87	110	156.30 ± 0.44 ^{AC}	151.04 ± 0.30 ^{AC}	185.80 ± 0.88 ^{AE}	176.11 ± 0.74 ^A	21.10 ± 0.12 ^{Aeab}	19.82 ± 0.08 ^A
2	93	97	155.86 ± 0.44 ^{Aa}	152.41 ± 0.34 ^{Aa}	192.04 ± 0.79 ^A	175.37 ± 0.79 ^A	21.79 ± 0.10 ^E	20.33 ± 0.10 ^{Ca}
3	86	89	157.26 ± 0.47 ^{ACb}	152.33 ± 0.38 ^{ACb}	197.00 ± 0.79 ^{BCD}	182.96 ± 0.82 ^C	22.50 ± 0.12 ^{CD}	20.66 ± 0.10 ^{abc}
4	149	133	157.00 ± 0.24 ^{AC}	154.75 ± 0.26 ^{AC}	196.91 ± 0.37 ^{Ca}	187.00 ± 0.41 ^{CB}	22.74 ± 0.05 ^{Cda}	20.67 ± 0.06 ^B
5	150	143	157.40 ± 0.22 ^{ACb}	154.49 ± 0.23 ^{ACb}	198.11 ± 0.43 ^D	189.37 ± 0.46 ^B	22.61 ± 0.04 ^D	21.41 ± 0.05 ^B
6	136	119	158.31 ± 0.33 ^C	156.12 ± 0.37 ^C	198.92 ± 0.54 ^D	190.78 ± 0.74 ^B	22.41 ± 0.07 ^{Cb}	21.49 ± 0.07 ^{Babd}
7	107	108	160.25 ± 0.41 ^B	157.00 ± 0.31 ^B	194.55 ± 0.68 ^{BCb}	190.42 ± 0.57 ^B	21.89 ± 0.09 ^{Babd}	21.83 ± 0.08 ^{Babd}
8	103	106	160.31 ± 0.39 ^B	156.44 ± 0.28 ^B	187.89 ± 0.67 ^C	182.48 ± 0.55 ^C	21.07 ± 0.07 ^A	20.37 ± 0.06 ^{Cb}

Data are reported as means ± SE. Means with different letters within a column differ from one another at $P < 0.05$ (a, b, c, d) and $P < 0.01$ (A, B, C, D).

The same trend was observed in the females, measuring about 151 cm (class 1) and reaching 156-157 cm over the last 20 years; the differences found were significant ($P < 0.01$). This continuous and constant trend to become taller was more evident in the last 20 years, and it clearly identifies the historical period during which these animals better responded to the selection process, incorporating the desired trait.

Also the average chest girth increased both in males and in females from 185.80 and 176.11 cm to 198.92 and 190.78 cm in class 6, respectively. These values significantly ($P < 0.05$) decreased to 187.89 and 182.48 cm in the last two periods for males and females, respectively. This trend was replicated by the average values for the circumference of the cannon bone, with an initial progressive increase from 21.10 and 19.82 to 22.89 and 21.83 cm in class 6, followed by stabilization at 21.07 ($P < 0.05$) and 20.37 cm for males and females in class 7, respectively.

Heritabilities

The heritability value calculated for height at withers was rather low (0.24, Table 2) and generally consistent with the results in the literature (0.26, von Butler-Wemken, 1990; 0.27, Baban et al., 1998), although Zechner et al. (2001) reported a value of 0.52 for Lipizzan horses and Miserani et al. (2002) found 0.61 for the Pantaneiro breed.

Table 2. Estimates of sire's (σ_s^2) and environmental (σ_e^2) variance components, heritabilities (h^2) and standard error (SE_h^2) for Murgese horse conformation traits.

Trait	σ_s^2	σ_e^2	h^2	SE_h^2
Height at withers	0.95	14.94	0.24	0.167
Chest girth	4.04	36.99	0.39	0.181
Cannon bone circumference	0.10	0.81	0.44	0.186

Molina et al. (1999) estimated heritabilities in Andalusian horses of 0.49 for chest girth and of 0.35 for forelimb cannon bone circumference (vs 0.39 and 0.44 reported in the present study, respectively). Baban et al. (1998) estimated heritabilities for the Lipizzan horse population of Djakovo, which were 0.25 for chest girth and 0.18 for cannon bone circumference. Pikula et al. (1998) estimated lower values for height at withers for cold-blooded horses with 0.16, 0.09 for chest girth and 0.23 for cannon bone circumference; the highest value (0.83) for thorax perimeter was found for the Pantaneiro horse breed by Miserani et al. (2002). The values in our study of the Murgese horse breed (Table 2) are based on a rather small number of observations for a conclusive analysis.

CONCLUSIONS

Thanks to its highly appreciated rustic nature and conformation, the Murgese horse has preserved its high value over the course of time. Today this horse is bred for special performance traits that are different from those of the past.

Current selection is now directed towards obtaining a taller, more distinct and better saddle horse; our morphometric findings at least partially reflect these new breeding goals. The heritability estimates that we found, though moderate (ranging from 0.24 to 0.44), suggest that mass selection is resulting in a positive response.

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